# AC 2010-871: GREEN INITIATIVE IN CAMPUS FOLLOWED BY CURRICULUM DEVELOPMENT OF A COURSE CONCENTRATING ON SELECTED CHOICES OF ALTERNATIVE ENERGY SOURCES IN EET PROGRAM IN TERMS OF GLOBAL AND ENVIRONMENTAL IMPACTS.

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# Green Initiative in the Campus Followed by Curriculum Development of a Course Concentrating on Selected Choices of Alternative Energy Sources in EET Program in Terms of Global Economic and Environmental Impacts.


Abstract

'Greening the work place' is not just a used term today but a homely speech. As the world's thirst for energy continues to grow, there is an urgent demand for a well trained workforce to develop, process, utilize and manage alternative energy sources in an environmentally and economically feasible way. The recent price hikes in energy have accelerated the decade long desire of the public to reduce dependency on foreign fossil fuels and ensure a sustainable energy supply for this nation. Obviously the quest for an alternative to fossil fuels will add to the growing global effort to combat climate change. Proper use of energy is considered as one of the biggest problem of the world; therefore, technical students must be familiar with the clean energy sources such as solar, wind, geothermal, biofuels etc.

Since the middle of 2008, Northwestern State University at Natchitoches, LA has taken on an initiative to promote a green, healthy, and environmentally friendly campus. In order to make this process more attractive and meaningful I will offer one survey course online for all disciplines in alternative energy during summer 2010. The second course will be offered in classroom environment during spring 2011 with more technical stuffs suitable for EET and IET students. The author will justify the concentration on solar, wind and geothermal energies over other alternative energy sources through economic aspects and environmental issues. A comparison study in this field with some Asian countries will also be discussed.

Simultaneously, business and industry are increasingly seeking graduates with appropriate background and training in this emerging and lucrative field of alternative energy. The improving economy and alternative energy sources are combining to create a brighter employment outlook for engineers and technologists in energy engineering. The experts are expecting a solar market tornado as it has transformed into a worldwide movement and the growth will be around US$ 30 billion and US$ 200 billion in 2010 and 2020 respectively. Students will be motivated by understanding that a career in renewable energy is both rewarding and a positive contribution to the fight against global warming. The impact of alternative energy on global economy is undeniable and its proper use is highly desirable.


## Introduction

United States consumes almost one quarter of world's total consumption of energy. 85 percent of it comes from fossil fuels. Starting in 1973, the oil embargo of the West by the OPEC, (Oil Producing and exporting countries) cartel and the last year's price hike of oil served as a wakeup call for the United Sates. However, we failed to get energy independence because of the lack of proper energy policy. The demand of energy is increasing rapidly due to the rising living standards and expanding population in countries around the world [1].

The demand also exceeds the oil production especially as the populous countries like China, India, Indonesia etc. are racing to achieve the same quality of life enjoyed in the West, as it is directly related to the per capital energy consumption. By 2050, the annual energy consumption in the world will be five times the current amount. Now the realization is that the component of energy policy must prepare a technical workforce in the alternative energy areas. In U.S alone the energy consumption has increased near 25% from 1970 to 2008 and the subsequent imported energy resources also increased proportionally. The grassroots efforts to develop renewable energy are getting strong support from the consumers. The fastest growing renewable energy systems are wind and solar (photo voltaic cells) PV since 2007. We must involve all our efforts to ensure the outcomes of American Recovery and Reinvestment Act (ARRA) signed by President Barack Obama in order to reduce consumption at least 35% by 2030, to create 5 million jobs by investing $150 billion dollars over the next 10 years, to ensure 10 percent of our energy comes from renewable sources by 2012 and to reduce greenhouse gas emission 80 percent by 2050. Academia is feeling significant pressure to offer professional programs with courses in alternative sustainable energy to produce a technical and scientific workforce[2].

To keep up with the national trend I will offer an online survey course called introduction to alternative energy for all disciplines in the campus during summer 2010. This paper describes the on-going development of this course. The course syllabus has already been approved by the university curriculum committee and the industry advisory board. Several students in the campus and alumni working in various companies have expressed interest in it. This course will provide many educational benefits for all involved including, but not limited to understanding the fundamentals of renewable energies, its uses, comparison study of different renewable energies, and its environmental effects and exposure to international renewable energy technologies.

The goals are to provide a broad overview of alternative energies so that the students are eager to continue the pursuit of energy alternative as graduates and future leaders.

Northwestern Green

Northwestern State University (NSU) at Natchitoches, LA has been characterized as the first designated Tree Campus USA University in Louisiana by the Tree Campus USA program launched by Arbor Day foundation in 2008. During this time NSU has begun a green initiative which includes behavioral change, recycling, campus beautification, infrastructure, and energy conservation. The faculty, staff and students were brought on board. NSU was chosen as a 2009 Tree Campus USA University for its dedication to campus forestry management and environmental stewardship. In 2009, NSU officials have assessments from energy management contractors to evaluate how efficiency of the current campus infrastructure. The old system made it too difficult to provide power to the campus in a reliable way. The goal is to make the campus more energy efficient to save money in operations. The new system will provide an individual meter for each facility instead of a meter per designated grid area to continually monitor usage and to implement measures to reduce energy use, especially during peak periods. Some students believe that paying a small cost of bi-annual surcharge is a small price for being more energy efficient. The print shop, the grounds crew, and Red River Janitors have started using more environmentally friendly products and supplies. They are following the same procedure during

renovations and construction. Recycling paper, plastic and aluminum is also encouraged in buildings on campus[3].

Course Objectives

The student should be able to:

- Understand, analyze, and explain the shift to alternate energy resources.
- Understand and explain solar power resources such as photovoltaic technologies and thermal applications.
- Understand and explain wind energy systems.
- Understand and Explain geothermal energy systems.
- Understand and explain biomass and transportation energy systems.
- Understand and explain ocean wave energy.
- Compare energy systems in the United States with those of the developing world.

Course topics

- Systems Tools for Energy Systems: Conserving existing energy resources versus shifting to alternate resources. The concept of sustainable development.
- Solar Energy Resources: Availability of energy from the Sun, fundamentals of PV cell performance, design and operation of practical PV systems, active and passive solar heating systems.
- Wind Energy Systems: Alternate wind turbines, using wind data to evaluate a potential location, estimating, output from a specific turbine, and economics of wind power.
- Geothermal Energy systems: Introduction, resources, energy systems, ground-source heat pumps.
- Biomass Energy Systems: Introduction of biomass fuels, such as wood, corps, manure and some garbage, bio-refineries, application of biomass in the U. S. and the developing world.
- Transportation Energy Technologies: Biofuels and hydrogen fuel cell systems.
- Comparative Studies: Alternate energies of the United States with respect to the developing world.

Teaching Schedule

The teaching schedule for the 12 weeks online delivery is as follows. All course materials (except the text book) are available online.

| Week | Topic |
|---|---|
| #1 | Introduction to alternative energy sources. |
| #2 | Wind energy: Fundamentals of wind energy, alternate wind turbines, using wind data to evaluate a potential location, estimating output from a specific turbine |
| #3 | Economics of wind power, environmental impacts, wind energy application, and **Exam #1.** |
| #4 | Solar energy: Availability of energy from the sun and geographic availability, fundamentals of PV Cell performance. |
| #5 | Design and operation of practical PV system, economics of PV system |

| | |
|---|---|
| #6 | Life cycle of energy and environmental consideration, active solar heating system, and **Exam #2.** |
| #7 | Passive Solar heating systems, geothermal resource, geothermal energy system, geothermal examples. |
| #8 | Geothermal power plants, geothermal heat pumps. Geothermal energy and environments, examples. |
| #9 | Introduction to Biomass. Biomass fundamentals, and **Exam #3.** |
| #10 | Municipal solid waste (MSW) application and biomass in the U.S and the developing World |
| #11 | Biofuel or fuels cell fundamentals, fuel cell types, and fuel cell availability. |
| #12 | Ocean thermal energy conversion (OTEC), tidal energy, wave energy, comparison studies with the developing world, and **Final Exam.** |

Rationale

As the world is transforming, it will be a great idea to change our life for better by joining the fastest growing green job arena which is expected to be a 1.5 trillion dollar industry [4]. This market will only continue to grow. As the world has currently been experiencing a great shortage of energy, the energy which is everywhere surrounding the environment should be considered to be captured, stoned, conditioned and utilized by alternative techniques. Green energy area is vast. So the concentration on its different aspects should also be different in order to obtain higher efficiency and usefulness. The author thinks that we should concentrate more on solar, wind, geothermal, and less on bio-fuels, biomass, etc.

Solar Energy:

The earth receives more energy from the sun in just one hour than the world uses in a whole year. The traditional energy sources such as coal and natural gas are facing a number of challenges including rising prices, security concern over dependence on imports from foreign continues having significant but limited fossil fuel supplies, and growing environmental concerns over the climate change due to carbon emission during power generation. It has emerged as one of the most rapidly growing renewable source of electricity as it has the following advantages:

- Solar Energy production does not require fossil fuels.
- Generates electricity with a limited impact on the environment as compared to other forms of electricity production.
- When electricity demand peaks in summer, solar energy can effectively supplement electricity supply from an electricity transmission grid.
- Applications of solar technology are readily available and versatile.
- Solar power production facilities can be installed at the customer site which in turn reduces the investment in production and transportation areas.
- Different Government incentives for developing solar as well as other renewable energy systems[5].

Wind Energy:

Humanity has been using the wind to do work for thousand years. At this time of high price of conventional energy sources, the wind energy has been enjoying the most rapid growth of all renewable energies. The Wind energy accounted for 4 percent of the renewable energy used in the United Sates in 2007 and is gradually increasing. With the advancement of wind turbines through newer technology and better understanding of the dynamics of the wind source, this process has been accelerated. The renewable portfolio standard (RPS) implemented by federal government forces the companies generating electricity in the U.S to obtain part of the electricity it supplies from renewable energy sources such as wind. At the same time the 'next metering laws' which in effect forces the utility company to buy power from wind turbine owners, at full retail rates. Now a day's net metering popularity is growing among states by either enacting it or considering it[6]. More than 30 U.S states have implemented aggressive renewable portfolio standards, which require that electric utilities obtain 10% to 30% of their energy from renewable sources. The U.S. department of Energy has set up a goal to supply up to 20% by the viability of wind energy[7].

The advent of floating wind turbines in comparison to existing off shore turbines is bringing new hope. Winds on the open oceans are also stronger and steadier than in coastal areas. As a result the turbines would be more productive. It is not cost effective to build a massive structure that's pounded into the seabed beyond 50 meters. In that case the floating turbines make the most economic sense for deep waters. According to the World Energy Council, today's shallow water turbines cost between $2.4 and $3 million per megawatt to install. The floating turbines will significantly be less expensive since they would not need seabed construction, large ships, or equipment out at sea, or require decommissioning a large installed structure[8]. The bottom line is that it is very much environmentally friendly.

Geothermal:

Geothermal energy is the heat from within the earth. Temperatures hotter than the surface of the sun are continuously produced inside the earth by the slow decay of radioactive particles in all rocks. Mankind uses geothermal energy to heat their homes and to generate electricity by digging deep wells and pumping the heated underground water or steam to the surface. Naturally occurring large areas of hydrothermal resources are called geothermal reservoirs. Three main uses of geothermal energy are as follows:

- Hot water from springs or reservoirs near the surface in direct use and direct heating systems.

- The United States generates more geothermal electricity than any other country.

- Geothermal heat pumps use the Earth's constant temperatures between $50^0$ and $100^0$ Fahrenheit to heat and cool buildings. In recent years the U.S. Department of Energy along with the EPA have partnered with industry to promote the use of heat pumps. As a result the heat pumps are becoming more popular.

The environmental impact of geothermal energy is minimal. Geothermal power plants release less than 1% of the carbon dioxide emission of the fossil fuel plant. They emit 97% less acid rain causing sulfur compounds than those of fossil fuel plants. The used water is always injected back into the earth. Obviously, there will not be any negative impact on the environment if direct use and heating applications are made.

Bio-fuels Energy Systems:

Using food to make transportation fuel such as ethanol is too expensive. It did not work as it also affects the food supply for the human beings as well as animals. Some companies are using non-food cellulose such as sorghum, agricultural and wood waste to make fuels for car. The future will tell its effectiveness.

A Comparison Study

The United States is the fastest- growing wind market worldwide. Texas is leading the nation even the growth is distributed across much of the U.S. Market growth is spurring manufacturing investments in the United States by both national and international companies. Wind remained economically competitive in 2008. In recent years the wind is consistently priced at or below that of conventional electricity despite increasing project costs. The industry is predicting market resurgence in 2010 after a slower 2009 due to recession. Solar energy is also a big business today. The experts are expecting that the solar PV market will grow from the current (2009) US$7 billion to US$30 billion in 2010 with annual growth rate exceeding 30%. As the profit margin is expanding the solar PV is becoming one of world's fastest growing profitable industries. California law requires the investor-owned utilities to generate 20% of their electricity renewably by 2010 and 33% by 2017. Throughout 2008 and the beginning of 2009, more than 1000 additional MW of geothermal power come on line in the United States. The U.S. Bureau of Land Management (BLM) leased 301,588 acres of land for geothermal power development during 2008/2009. The United States has signed the International Partnership for Geothermal Technology (IPGT) with Iceland and Australia. Investments in geothermal is continued to grow. Both small and modular low temperature electricity generations are the significant portions of the overall geothermal market[9].

Floating Wind energy firms are ideal for countries such as Norway, Italy, and Japan which do not have shallow coastal water. According to the Wind Energy Council 810 of more than 1000 gigawatts of off-shore wind potential are in water deeper than 30 meters. So, this will make a strong case for the United States to install floating wind turbines.

The United Arab Emirates as an important oil producer with the fifth largest proved oil reserves in the Middle East has been producing 97% of the electricity using natural gas. The demand for electricity in the UAE has been growing at double digits for many years and will continue to do so until at least 2010. The country has come to realize two facts based on Kyoto protocol and awareness. The first one is that the conventional energy sources such as oil will deplete sooner or later, and the second is the higher carbon emissions will further pollute the environment. As a result, the government of Abu Dhabi initiated ambitious plans for solar, biomass, wind and other renewable energy projects. Dubai electricity and water authority has launched a pilot project using wind energy to replace conventional energy sources. The gulf region enjoys sunshine for

around 300 days for an average of nine hours per day. The solar energy projects are also getting priorities. They are interested in saving high value fossil fuels for exports by exploring other sources of energy[10].

China wind power industry has doubled installations in 2008 for the fifth year in a row neglecting the international financial crisis. Only the capacity of its power grids to absorb energy resulting from the wind power surge can check its expansion. The development is so good that the wind firms could meet all new electricity demands in China through 2030 at reasonable low cost. Even though China's wind market has indeed doubled for the past two years, approximately 30% of the new capacity remained unconnected to the grid at the end of each year. Coal fired power plants are still being constructed. Hope is that for climates sake it will ultimately slow down[11].

In Bangladesh both government and non-government organizations (NAOs) are working to bring sustainable energy to the rural population. The idea is to empower the poor to the extent possibly towards sustainable livelihoods. The concentration is given mostly on solar PV systems and the wind energy systems. Power development board (PDB) of Bangladesh completed the installation of 0.9 MW capacity of the Grid concentrated wind energy in Muhari Dam area. PDB is also implementing solar PV electrification projects in the southern regions. The Rural Electrification Board (REB) works through Parli Bidyut Samities (PBS) [Rural Electric Societies] based on the Model of Rural Electric Cooperatives in the USA and installed 22,000 solar home systems with the assistance from GTZ (German Technician Cooperation). The center of energy studies (CES) of Bangladesh University of Engineering and Technology (BUET) organizes different training programs, workshops, and seminars monthly with the different leading universities is the field of renewable (e.g. solar wind, hydros) energy. BRAC, (Bangladesh Rural Advancement Committee), a national private development organization installed 6076 solar based lighting systems through its Rural Energy Program (REP). PSL (Prokaryotic Sangrad Ltd) has built up solar PV systems which are supplied through rural woman owned co-operatives at the village levels. Another public company called Rahimafrooz Batteries Ltd has installed 30,000 home solar systems in the remote areas of Bangladesh. It has so far participated in UNDP (United Nations Development Program), FAO (Food and Agricultural Organization) World Bank and Shell Foundation Programs involving the dissemination of solar PV based products[12].

## Conclusion

NSU is thinking and focusing on the environment, energy conversion, and sustainability through a new initiative known as Northwestern Green which is definitely a positive approach to be followed by other campuses nationwide. The consumers have learned more about the air pollution, strip mining, and other harmful environmental impacts of electricity generation from the United Nations conference on climate change at Copenhagen, Denmark during December, 2009. We must utilize this awareness of the public to get energy independence by developing more and more renewable energy sources. In this paper I have justified the concentration on solar, wind and geothermal as these are not only renewable, but also environmentally friendly. It is also encouraging that many in engineering and technology, corporate and political committees advocate greater stance on alternative energy. The author has presented the utilization of especially solar and wind out of all kinds of alternative energies in some developing countries in Asia. An introductive course in alternative energy has been developed in which students from all

across a campus can enroll and contribute towards developing a workforce with environmental awareness. The engineers and the technologists must figure out the way to use unlimited availability of renewable energies in an economic way in contrast to fossil fuels which are finite and ultimately expensive.

I am going to offer a second course in this area for the students in the engineering technology program with design aspects as well as connection procedures to the smart grid in spring 2011. It will be presented in the next paper. It is anticipated that the improving economy and alternative energy sources are combining to create unique opportunities to obtain energy independence as well as keeping the environment green. Overall, this course will provide the theoretical foundation of alternative energies for students all over the campus and a few may be motivated to pursue a career in this lucrative and emerging field.

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